DEPARTMENT OF THE INTERIOR

CANADA

HON. W. J. ROCHE, *Minister.* W. W. CORY, C.M.G., *Deputy Minister.*

PUBLICATIONS

OF THE

Dominion Observatory

OTTAWA

W. F. KING, C.M.G., LL.D., *Director.*

Vol. I, No. 10

Orbit of *b* Persei

BY

J. B. CANNON, M.A.

OTTAWA
GOVERNMENT PRINTING BUREAU
1914

DEPARTMENT OF THE INTERIOR

CANADA

HON. W. J. ROCHE, *Minister.* W. W. CORY, C.M.G., *Deputy Minister.*

PUBLICATIONS

OF THE

Dominion Observatory

OTTAWA

W. F. KING, C.M.G., LL.D., *Director.*

Vol. I, No. 10

Orbit of *b* Persei

BY (title)

J. B. CANNON, M.A.

OTTAWA
GOVERNMENT PRINTING BUREAU
1914

60443—1

ORBIT OF b PERSEI.

BY J. B. CANNON, M.A.

b Persei ($\alpha = 4^h\ 10^m.7$, $\delta = +50^\circ\ 03'$, mag. 4·5) was announced a binary by Prof. Campbell early in 1910* from measures of four plates taken, two in 1903, one in 1906 and one in 1909. Its spectrum is of A-type and a few of the plates obtained here show double lines. In the second spectrum thus appearing, the lines are not at all well defined and measures on them are only fair as will be seen by the magnitude of the residuals. The lines which show doubling are H_γ, H_δ, and in one case the iron line λ4045.

Thirty-six plates dating from October 10, 1910, to April 24, 1911, were taken in all. The lines are about the average for this type. Being a double spectrum and the two components being separable in only a few plates, the measuring is more difficult than it would otherwise be. All plates were taken with the single-prism spectrograph, the length required for using the three prisms being too great for a star of this magnitude. Seed 27 plates were used throughout for the same reason, although a finer grained plate might have been very advantageous for showing doubling of lines.

The lines measured were:—

TABLE I.

Element.	Wave-Length.	Element.	Wave-Length.
Hydrogen	4861·527	Magnesium	4481·400
Hydrogen	4340·634	Iron	4549·766
Hydrogen	4101·890	Iron	4045·975
Hydrogen	3970·177†	Calcium	3933·825

*L. O. B. V. 174. †Only on one or two plates.

Other iron lines appeared in a few of the plates but for the most part were not measurable.

Tables of observations follow. Table II contains the Lick observations and Table III the Ottawa observations. The phases are from corrected periastron, and the residuals from the corrected curve.

TABLE II.

LICK OBSERVATIONS.

Plate.	Observer.	Date.	Exposure.	Julian Day.	Phas.	Component I.			Component II.		
						Vel.	Wt.	O-C.	Vel.	Wt.	O-C.
		1903									
..	..	Nov. 3.....	..	2,416,422·024	1·209	+28·3	..	−12·5			
..	..	Nov. 16.....	..	435·989	1·428	− 3·5	..	− 0·5			
		1906									
..	..	Sept. 19.....	..	7,473·978	0·840	+49·5	..	− 6·3			
		1909									
..	..	Sept. 2.....	..	8,552·017	0·591	+52·5		+12·5			
		1910	..								
..	..	Oct. 15.....	..	960·909	0·161	−31·4	..	− 9·6			

TABLE III.

OTTAWA OBSERVATIONS.

Plate	Observer*	Date.	Exposure.	Julian Day.	Phase.	Component I.			Component II.		
						Vel.	Wt.	O-C.	Vel.	Wt.	O-C.
		1910	m.								
3728	P[1]	Oct. 10.....	60	2,418,955·830	1·191	+35·4	1·5	− 7·6			
3738	C	Oct. 12.....	60	957·760	·067	−27·6	5·5	− 1·6			
3809	P[1]	Nov. 9.....	72	985·630	·445	+12·8	3·7	− 9·2			
3819	H	Dec. 5.....	70	9,011·720	·561	+41·8	2·5	+ 5·3			
3826	P[1]	Dec. 6.....	77	012·790	·114	−36·6	1·5	− 9·5			
3854	P	Dec. 10.....	50	016·720	·989	+51·3	2·7	− 5·2			

OTTAWA OBSERVATIONS—*Continued.*

Plate	Observer.*	Date.	Exposure.	Julian Day.	Phase.	Component I.			Component II.		
						Vel.	Wt.	O-C	Vel.	Wt.	O-C
		1910	m.								
3862	C-H	Dec. 12.....	60	2,419,018·730	[illegible]	− 8·9	1·0	+ 4·1			
3870	P¹	Dec. 15.....	70	021·620	1·297	+ 9·2	3·0	−16·8			
3875	H	Dec. 16.....	70	022·640	·800	+50·7	2·2	− 3·3			
3885	P¹	Dec. 21.....	68	027·540	1·118	+51·9	3·0	+ 1·4	− 81·5	·2	− 5·0
3907	H	Dec. 30.....	65	036·715	1·129	+59·7	3·2	+ 9·7	− 70·4	·7	+ 1·6
		1911									
3919	C	Jan. 5.....	60	042·719	1·024	+51·0	4·5	− 5·5			
3931	P	Jan. 12.....	110	049·680	·349	+ 4·4	2·7	− 2·6			
3939	C-H	Jan. 16.....	74	053·724	1·338	+24·2	4·7	+ 6·7			
3949	H	Jan. 17.....	60	054·792	·878	+59·3	3·2	+ 2·8			
3960	P¹	Jan. 18.....	112	055·666	·225	−10·0	·5	+ 3·0			
3963	P	Jan. 19.....	60	056·642	1·201	+48·4	4·5	+ 6·4			
3996	P¹	Feb. 15.....	65	083·610	·678	+43·3	5·0	− 3·7	− 78·7	·2	−16·7
4005	C	Feb. 20.....	68	088·530	1·016	+59·0	4·2	+ 2·5			
4017	H	Feb. 25.....	61	093·510	1·414	− 3·3	3·0	− 2·8			
4018	C	Feb. 27.....	70	095·490	·340	+ 5·8	3·7	± 0·0			
4031	H	Feb. 28.....	60	096·530	1·379	+14·1	3·0	+ 2·0			
4033	P¹	Mar. 1.....	87	097·643	·965	+60·2	3·2	+ 3·6			
4034	P	Mar. 2.....	45	098·491	·286	+ 3·1	3·2	+ 6·6			
4057	C	Mar. 6.....	68	102·549	1·289	+20·8	3·7	− 6·7			
4068	H	Mar. 7.....	69	103·580	·793	+45·3	4·2	+ 3·7	−119·0	·2	−33·0
4078	P¹	Mar. 8.....	75	104·583	·269	−14·3	3·5	− 8·3			
4087	C	Mar. 10.....	68	106·542	·700	+55·6	3·5	+ 6·6			
4100	C	Mar. 13.....	75	109·560	·664	+45·4	2·5	− 0·6			
4112	H	Mar. 14.....	70	110·550	·127	−22·7	3·5	+ 2·5	+168·8	·6	−28·2
4135	C	Mar. 24.....	70	120·542	·955	+58·7	2·5	+ 2·0	− 77·3	·2	+22·7
4143	H	Mar. 28.....	77	124·658	·489	+33·5	2·2	+ 5·5			
4176	C	April 10.....	70	137·542	1·154	+47·8	2·7	− 0·2			
4185	H	April 11.....	70	138·536	·621	+34·4	3·0	− 7·6			
4195	H	April 14.....	75	141·550	·580	+42·1	2·7	− 4·9			
4246	C	April 24.....	70	151·542	1·409	+ 3·5	2·7	+ 2·5			

*P=Plaskett; H=Harper; P¹=Parker; C=Cannon.

MEASURES OF *b* PERSEI.

λ	3728		3738p.*		3738s.*		3809		3819		3826		3854	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	+ 7·54	¼					+ 23·43	½	+ 60·71	½				
4549·766	+ 22·24	½	− 39·75	½	+100·98	¼			+ 33·08	¼			+ 69·90	¼
4534·139													+ 59·87	¼
4481·400	+ 14·91	½	− 55·16	1			+ 13·63	1	+ 50·62	½	− 34·15	1	+ 62·99	1
4395·286													+ 35·55	½
4352·006	+ 7·80	¼												
4340·634			− 49·29	¼	+124·27	¼	− 0·81	1	+ 30·41	½			+ 47·44	½
4101·890			− 47·91	½					+ 41·79	½				
3970·177							+ 0·96	¼						
3933·825			− 44·62	1½			− 14·13	1	+ 37·11	¼				
Weighted mean	+ 14·93		− 47·53		+112·62		+ 2·84		+ 43·72		− 34·15		+ 55·50	
V_a	+ 20·70		+ 20·12		+ 20·12		+ 10·14		− 1·56		− 2·06		− 3·87	
V_d	+ ·01		+ ·09		+ ·09		+ ·14		− ·05		− ·14		− ·07	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 35·4		− 27·6		+ 132·6		+ 12·8		+ 41·8		− 36·6		+ 51·3	

* p. = primary.
s. = secondary.

MEASURES OF b PERSEI—*Continued.*

λ	3862		3870		3875		3885p.		3885p.		3885s.		3907p.	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	.....	.....	+ 24·73	¼	+ 67·61	¼	+ 49·59	½	+ 53·00	½	.....	.....	.....	.....
4549·766	.....	.....	+ 17·61	1½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4534·139	.....	.....	.....	.....	.....	.....	.....	.....	+ 66·40	¼	.....	.....	.....	.....
4481·400	− 5·86	¼	+ 5·36	¼	+ 69·54	½	+ 73·31	1	+ 73·57	1½	.....	.....	+ 64·18	1½
4340·634	− 4·51	¼	+ 9·14	½	+ 58·89	½	+ 81·45	¼	+ 82·61	¼	− 72·43	¼	+ 80·99	½
4308·081	− 0·56	¼	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4128·211	− 4·03	¼	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4101·890	.....	.....	.....	.....	+ 33·90	½	+ 37·65	¼	.....	.....	.....	.....	+ 88·98	¼
3933·825	.....	.....	+ 16·06	½	+ 62·65	½	+ 45·26	1	+ 50·84	½	.....	.....	+ 77·46	½
Weighted mean	− 3·74		+ 15·51		+ 57·50		+ 57·71		+ 66·51		− 72·43		+ 72·76	
V_o	− 4·81		− 6·10		− 6·57		− 8·76		− 8·76		− 8·76		− 12·67	
V_d	− ·09		+ ·05		+ ·01		− ·05		− ·05		− ·05		− ·12	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 8·9		+ 9·2		+ 50·7		+ 48·6		+ 57·4		− 81·5		+ 59·7	

MEASURES OF *b* PERSEI—*Continued.*

λ	3907s.		3919		3931		3939		3949		3960		3963	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	.....	.....	+ 85·12	½	+ 16·38	¼	+ 53·64	¼	+123·98	¼	.....	.....	+ 97·32	½
4549·766	.....	.....	.....	.....	.....	.....	+ 44·89	½	+100·58	½	.....	.....	.....	.....
4481·400	.....	.....	+ 64·06	2	+ 19·40	1½	+ 43·24	1½	+ 77·42	1½	+ 9·82	½	+ 57·52	1
4352·006	.....	.....	+ 66·87	½	.....	.....	.....	.....	+ 65·12	½	.....	.....	.....	.....
4340·634	− 57·04	½	+ 99·50	¼	+ 28·46	1	+ 42·58	½	+ 53·22	½	.....	.....	+ 71·50	1
4101·890	− 58·07	¼	+ 90·23	¼	.....	.....	.....	.....	.....	.....	.....	.....	+ 79·16	½
3968·625	.....	.....	.....	.....	.....	.....	+ 40·29	½	.....	.....	.....	.....	+ 53·69	½
3933·825	.....	.....	+ 47·67	1	.....	.....	+ 43·51	1½	.....	.....	.....	.....	+ 63·56	1
Weighted mean	− 57·38		+ 66·49		+ 22·42		+ 43·66		+ 78·95		+ 9·82		+ 68·37	
V_a	− 12·67		− 15·06		− 17·63		− 18·98		− 19·18		− 19·39		− 19·59	
V_d	− ·12		− ·10		− ·12		− ·18		− ·21		− ·14		− ·10	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 70·4		+ 51·0		+ 4·4		+ 24·2		+ 59·3		− 10·0		+ 48·4	

MEASURES OF b PERSEI—*Continued.*

λ	3996p.		3996s.		4005		4017		4018		4031		4033	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
1861·527	+ 58·94	½	.....		+ 73·39	½	+ 28·75	½	+ 31·96	½	+ 52·52	½	+ 71·31	½
1549·766	+ 75·24	½	.....		+ 84·57	½	+ 12·27	½						
4534·139	+ 61·16	½												
4515·508	+ 85·93	½												
1481·400	+ 61·84	½	.....		+ 86·00	1	+ 29·20	1	+ 27·94	½	+ 56·02	1	+ 98·51	1
1352·006	.....		.....		.....		+ 47·50	½	+ 27·31	½				
4340·634	+ 77·75	1	.....		+ 94·41	1	− 11·11	½	+ 47·55	½	+ 23·60	½	+ 84·69	½
1325·939	.....		.....		.....		.....		+ 15·69	½				
1315·178	.....		.....		.....		.....		+ 15·34	½				
1101·890	+ 81·76	½	.....		+ 57·20	½	.....		.....		.....		+ 90·71	½
1071·901	.....		.....		+ 62·70	½	+ 19·46	½						
1063·756	+ 75·11	½	.....		.....		.....		+ 36·85	½				
1045·975	+ 60·01	½	− 51·65	½										
3933·825	+ 54·83	½			+ 94·93		+ 19·64	½	+ 35·53	1	+ 28·79	1	+ 83·87	1
Weighted mean	+ 69·36		− 51·65		+ 85·45		+ 23·48		+ 32·56		+ 40·95		+ 87·10	
V_o	− 25·66		− 25·66		− 26·12		− 26·39		− 26·44		− 26·46		− 26·45	
V_d	− ·14		− ·14		− ·04		− ·09		− ·05		− ·10		− ·19	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 43·3		− 78·7		+ 59·0		− 3·3		+ 5·8		+ 14·1		+ 60·2	

MEASURES OF [illegible] PERSEI—*Continued.*

λ	[illegible] Vel.	Wt.	[illegible] Vel.	Wt.	[illegible] Vel.	Wt.	4088a. Vel.	Wt.	4078 Vel.	Wt.	4087 Vel.	Wt.	4100 Vel.	Wt.
[illegible]	+ 2[illegible]		[illegible]		[illegible]·89	½			+ 1·82	¼	+ 91·38	½	+ 80·14	
[illegible]					77·[illegible]	¼			13·57	¼	+ 84·98	¼	+ 70·97	½
[illegible]	+ [illegible]	1	1[illegible]	1	71·[illegible]	1			+ 20·02	1	+ 78·73	1	+ 70·18	1
[illegible]									9·80	½				
[illegible]									— 31·39	¼				
[illegible]	+ [illegible]		[illegible]		+ 70·79	½			+ 9·60	½	+ 96·84	½	+ 87·27	¼
[illegible]									+ 27·94	¼				
[illegible]														
[illegible]	[illegible]	¼	[illegible]	¼	— 86·19	½	92·25	¼			+ 75·60	¼		
[illegible]	+ 21·[illegible]	1	+ 2[illegible]	1	8[illegible]·03	1			+ 24·21	½	+ 75·71	1	+ 49·12	¼
Weighted mean	2[illegible]·88		+ 1[illegible]·57		+ 72·0[illegible]		92·25		+ 12·45		+ 82·48		+ 71·76	
V_a	26·25		2[illegible]·[illegible]6		26·[illegible]1		26·31		26·22		26·14		25·89	
V	·07		·14		·16		·16		·18		·14		·17	
Curv	·28		·28		·28		·28		— ·28		— ·28		— ·28	
Reduced Velocity	[illegible]·1		20·8		47·[illegible]		119·0		— 14·2		+ 55·9		+ 45·4	

MEASURES OF b PERSEI—*Continued.*

λ	4112p.		4112a.		4135p.		4135a.		4143		4176		4185	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4864·527	12·00	½			+108·24	½			+ 55·09	¼	+ 78·11	¼	+ 41·51	½
4572·156									+ 52·09	¼				
4549·706	....								+ 81·98	¼			+ 83·78	¼
4481·400	− 9·56	1	.....		+ 67·63	½	.....		+ 47·47	½	+ 74·53	1	+ 64·34	1
4395·286	.....		.....		.....		.....		+ 30·10	¼				
4383·720	.....		.....		.....		.....		+ 80·77	¼				
4340·634	+ 1·97	½	.....		+ 92·10	¼	− 52·41	¼	+ 69·07	¼	+ 61·27	½	+ 36·18	½
4325·939	.....		.....		.....		.....		+ 43·51	¼				
4101·890	+ 24·43	½	+195·00	¼	+ 62·02	¼	.....		.....		+ 65·61	½	+ 59·36	½
3933·825	+ 15·37	1	.....		+ 82·45	1	.....		.....		+ 62·91	½	+ 44·04	¼
Weighted mean	+ 3·58		+195·00		+ 83·57		− 52·41		+ 57·61		+ 68·70		+54·98	
V_0	− 25·79		− 25·79		− 24·40		− 24·40		− 23·61		− 20·44		−20·15	
V_1	− ·16		− ·16		− ·18		− ·18		− ·19		− ·19		− ·19	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 22·6		+ 168·8		+ 58·7		− 77·3		+ 33·5		+ 47·8		+ 34·4	

MEASURES OF ζ PERSEI—*Concluded*

λ	1895		1896											
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	+ 52·95	1	0·96	1										
4549·766	+ 48·09	1												
4481·300	+ 62·15	1	+ 24·08	1										
4340·634	+ 77·80	1	+ 17·08	1										
4101·890			39·20	1										
3933·825	+ 66·16	1	42·65	1										
Weighted Means	+ 65·5	5	19·89	5										
V_1	19·23		15·92											
V_2	.21		+ .21											
C.W.	= .28		= .28											
Radial Velocity	+ 42·1		+ 8·5											

The observations were combined into fourteen groups and the resulting normal places used in obtaining, by means of Dr. King's graphic method, preliminary elements for the orbit. The normal places with mean velocities, mean phases, weights and residuals from final curve are given below.

NORMAL PLACES

	Julian Day.	Phase	Velocity.	Weight.	Residual
1	2,419,045·213	·464	+21·7	1·0	−2·21
2	100·036	·590	+39·6	2·0	+1·04
3	099·214	·682	+48·3	2·0	+1·66
4	068·469	·810	+49·4	1·5	−4·04
5	073·649	·961	+56·7	2·0	−0·10
6	069·281	1·020	+55·4	1·0	−0·37
7	078·533	1·137	+52·5	2·0	+3·41
8	018·838	1·197	+43·5	1·0	+0·77
9	064·280	1·312	+19·8	2·0	−3·93
10	116·991	1·399	+ 6·0	1·5	+1·88
11	018·730	1·472	− 8·9	·5	+3·52
12	017·472	·100	−27·3	1·5	−0·83
13	085·016	·252	−12·6	·5	−3·81
14	082·780	·318	+ 4·1	1·5	+2·11

The preliminary elements obtained were:—

$P = 1{\cdot}52732$ days
$e = {\cdot}25$
$\omega = 150°$
$K = 43{\cdot}5$ km.
$\gamma = 21{\cdot}92$ km.
$T = 2{,}418{,}956{\cdot}145$ J. D.

To get a closer approximation to the true values of the elements a least-squares solution was applied. P was assumed as determined but e, ω, K, γ and T were used in the solution.

Observation equations were formed as follows:—

x	y	z	u	v	$-n$	Weight.
1	+ ·072	+ ·405	+ ·832	− ·640	+3·350	1·0
1	+ ·390	− ·287	+ ·670	− ·471	−0·730	2·0
1	+ ·562	− ·685	+ ·503	− ·356	−1·940	2·0
1	+ ·722	− ·927	+ ·219	− ·196	+3·950	1·5
1	+ ·782	− ·811	− ·178	+ ·033	−0·760	2·0
1	+ ·758	− ·571	− ·348	+ ·119	−0·500	1·0
1	+ ·602	+ ·185	− ·699	+ ·459	−4·380	2·0
1	+ ·450	+ ·652	− ·871	+ ·672	−2·020	1·0
1	− ·024	+1·195	−1·106	+1·147	+1·080	2·0
1	− ·526	+ ·617	−1·076	+1·337	−6·950	1·5
1	− ·938	− ·469	− ·818	+1·070	−9·970	·5
1	−1·173	− ·374	+ ·166	− ·399	−1·820	1·5
1	− ·671	+1·019	+ ·765	− ·808	+5·310	·5
1	− ·416	+1·037	+ ·855	− ·831	−0·270	1·5

where $x = \delta\gamma$
$y = \delta K$
$z = K\delta e$
$u = K\delta\omega$
$v = \dfrac{K\mu\delta T}{(1-e^2)^{\frac{1}{2}}}$

Normal equations resulting from these observation equations were as follows:—

$$\begin{aligned}
20x + 3{\cdot}010y + {\cdot}483z - 1{\cdot}786u + 1{\cdot}772v - 22{\cdot}595 &= 0\\
+ 7{\cdot}852y - 3{\cdot}808z - {\cdot}187u - {\cdot}105v + 5{\cdot}719 &= 0\\
10{\cdot}569z - 3{\cdot}200u + 3{\cdot}458v - {\cdot}676 &= 0\\
10{\cdot}036u - 9{\cdot}506v + 23{\cdot}982 &= 0\\
9{\cdot}597v - 24{\cdot}408 &= 0
\end{aligned}$$

Solving these equations the values for the corrections were found to be:—

$\delta\gamma = +\ 1{\cdot}20$ km.
$\delta K = -\ 1{\cdot}925$ km.
$\delta e = -\ {\cdot}038$
$\delta\omega = +0°{\cdot}85$
$\delta T = +\ 0{\cdot}018$ day

The value of Σprv was greatly reduced being brought down from 241 to 128. Disagreement between computed and observation equation

residuals led to a second solution being made. Observation equations, determined from the corrected values of the elements using the same substitutions as before, are as follows:—

x	y	z	u	v	$-\pi$	p
1	+ ·012	+ ·579	+ ·877	− ·729	+1·940	1·0
1	+ ·368	− ·149	+ ·730	− ·549	−1·190	2·0
1	+ ·563	− ·907	+ ·560	− ·417	−1·760	2·0
1	+ ·746	− ·965	+ ·262	− ·228	+4·730	1·5
1	+ ·813	− ·817	− ·158	+ ·037	+0·230	2·0
1	+ ·787	− ·570	− ·336	+ ·166	+0·460	1·0
1	+ ·624	+ ·194	− ·691	+ ·488	−3·450	2·0
1	+ ·407	+ ·649	− ·861	+ ·695	−0·960	1·0
1	+ ·006	+1·144	−1·085	+1·115	+3·580	2·0
1	− ·461	+ ·653	−1·065	+1·272	−2·050	1·5
1	− ·849	− ·304	− ·851	+1·077	−3·270	·5
1	−1·175	− ·679	+ ·038	− ·193	+1·560	1·5
1	− ·766	+ ·841	+ ·711	− ·853	+3·880	·5
1	− ·513	+1·039	+ ·841	− ·876	−2·300	1·5

The consequent normal equations were:—

$$\begin{aligned}
20x + 3{\cdot}102y + {\cdot}528z - 1{\cdot}565u + 1{\cdot}555v - {\cdot}525 &= 0\\
8{\cdot}116y - 3{\cdot}332z - {\cdot}215u + {\cdot}005v - 1{\cdot}174 &= 0\\
10{\cdot}635z - 2{\cdot}973u + 3{\cdot}172v - 2{\cdot}693 &= 0\\
10{\cdot}157u - 9{\cdot}667v + {\cdot}683 &= 0\\
9{\cdot}612v - {\cdot}970 &= 0
\end{aligned}$$

The solution of these equations gave the second corrections —

$$\begin{aligned}
\delta\gamma &= -{\cdot}03 \text{ km.}\\
\delta K &= +{\cdot}31 \text{ km.}\\
\delta e &= +{\cdot}008\\
\delta\omega &= +0^\circ{\cdot}90\\
\delta T &= +0{\cdot}0035 \text{ day}
\end{aligned}$$

The new values for the elements gave satisfactory comparison between computed and observation residuals, and a second lowering of Σpvv from 128 to 126.

The probable error of a normal place of weight unity was computed and found to be $\pm 2 \cdot 5$, while that of a plate of average weight was $\pm 3 \cdot 9$.

The probable errors of the elements were also computed, and are given below after the final values of each.

The following table gives a summary of the values of the elements preliminary, first corrected and final:—

Element.	Preliminary.	First Corrected.	Final.	
P	1·52732 days	1·52732 days	1·52732 days	
e	·25	·212	·22	± 0·021
ω	150°	150°·85	151°·75	± 2°·08
K	43·5 km.	41·575 km.	41·89 km.	± 0·97
γ	21·92 km.	23·12 km.	23·09 km.	± 0·57
T	2,418,956·145 J. D.	2,418,956·163 J. D.	2,418,956·166 J. D.	± 0·02
$a \sin i$	.....	.....	837,600 km.	

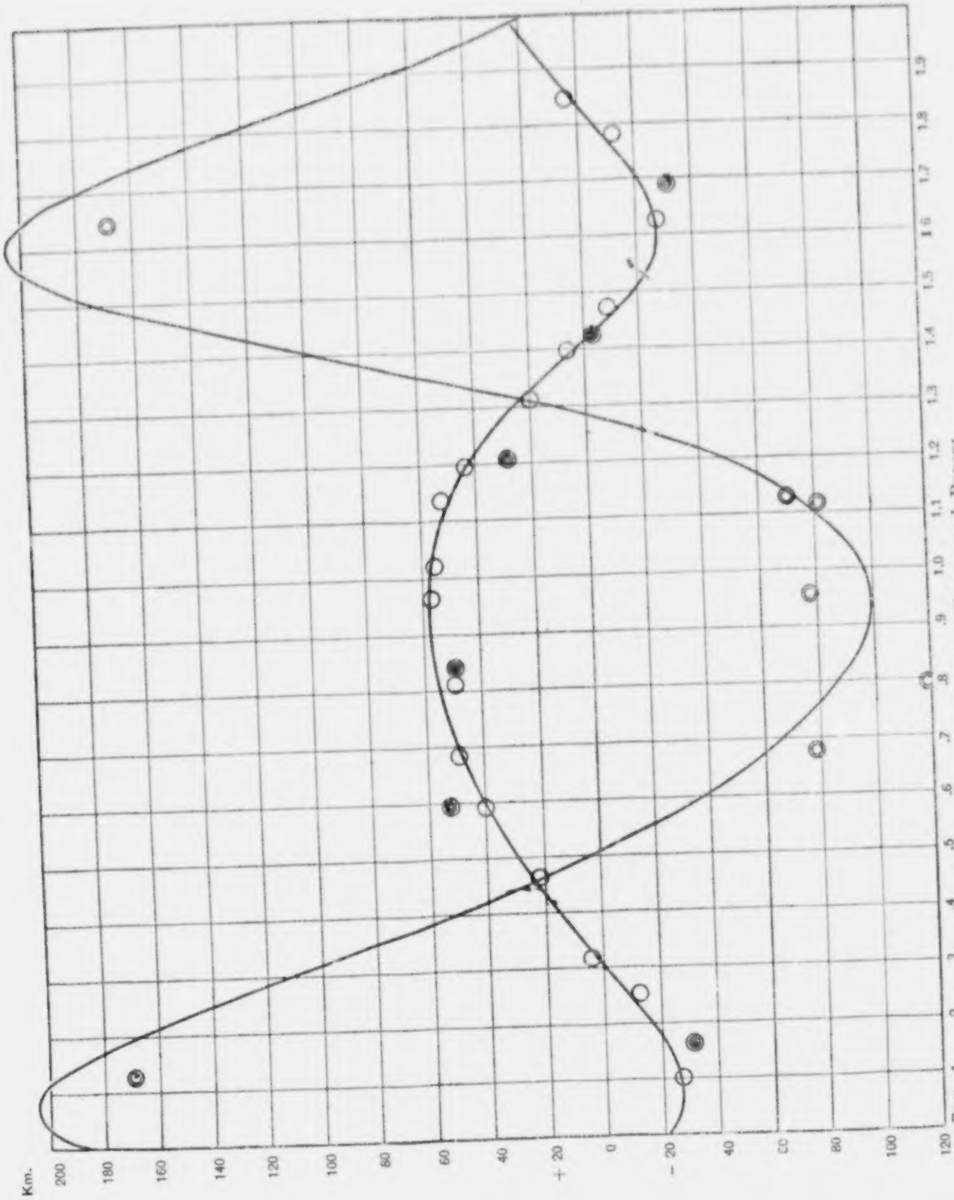
Coming to the secondary, only six plates showed lines measurable. No attempt was made to get elements independently of the primary, the number of plates not being considered sufficient for that. The values of γ and T finally accepted for the primary were taken for the secondary, ω_1 taken $180° + \omega$ and the K was obtained by trial graphically. Those given probably suit the six observations as well as any. The elements are:—

$$P_1 = 1 \cdot 52732 \text{ days}$$
$$e_1 = \cdot 22$$
$$\omega_1 = 331° \cdot 75$$
$$K_1 = 152 \cdot 5 \text{ km.}$$
$$\gamma_1 = 23 \cdot 09 \text{ km.}$$
$$T_1 = 2{,}418{,}956 \cdot 166 \text{ J. D.}$$
$$a_1 \sin i_1 = 3{,}048{,}000 \text{ km.}$$

The relation existing between the masses of the two bodies is given by $M : M_1 = K_1 : K = 152 \cdot 5 : 42$ or $3 \cdot 6 : 1$.

The figure gives the two curves. The double circles are the observations on secondary component and the triple circles are Lick observations.

Dominion Observatory,
Ottawa,
June, 1911.



VELOCITY CURVE OF *b* PERSEI.